Feasibility Study of Carbon Dioxide Injection System to Reduce Predation at Tracy Fish Collection Facility

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Summary

This study will investigate the feasibility of implementing a carbon dioxide (CO_2) injection system that will simplify and improve the predator removal process at the Tracy Fish Collection Facility (TFCF). Predation, particularly in the secondary channel and bypass pipes, is a significant problem at the TFCF that contributes to reduced fish salvage efficiencies. In past years, various methods of removing predators from the secondary channel have been studied (Liston *et al*. 1994). Most of these methods required the secondary channel to be drained which prevents continuous facility operation. More recently, insertion of CO_2 into the water has been studied as a method of predator removal (Wu *In Progress*). Preliminary results show that CO_2 is effective in changing fish behavior in such a way that predators can be driven to a desired location and easily removed. CO_2 quantities, exposure times, and behaviors of fish species specific to the TFCF have been determined from these studies. The application of results from this research to a CO_2 injection system that could be implemented at the TFCF will greatly enhance predator removal.

Current research testing at the TFCF includes insertion of dry ice into the water to obtain the required amounts of CO_2. While this method has been useful for research testing, it may not be a practical solution for routine predator removal at the TFCF. Many challenges make successful CO_2 insertion difficult including: insertion without impacting flow rates or flow stability, uninterrupted facility operation, holding correct levels of CO_2 for a required time period, fast, simple and safe operation for employees, and operation that is economically feasible. This study will use results from previous CO_2 research to develop and test two different prototype CO_2 injection systems that can be implemented at the TFCF. They will be developed to operate in a safe, simple, and economic manner. Along with the prototypes, this study will produce an engineering report defining the operational and economic feasibility of both CO_2 injection systems

compared to methods currently used at the TFCF. Laboratory and field test results as well as recommendations for long-term use of CO_2 injection will be presented.

Problem Statement

Predation is one of the factors that negatively affect the overall fish salvage efficiency at the TFCF. Predators, mostly striped bass, accumulate within many areas of the facility including the primary channel, the bypass pipes, and the secondary channel where predator removal is difficult. Research at the TFCF (Wu *In Progress*) has shown that introducing CO_2 into the water is effective in changing fish behavior, driving predators from areas where they cannot be removed. Results from these studies have determined the quantities and exposure times that are required to impact fish behavior for effective predator removal. While the affects of CO_2 on fish behavior is promising from a predation standpoint, a practical, permanent method of CO_2 injection is yet to be determined. Currently, CO_2 injection at the TFCF involves manual insertion of dry ice blocks into the bypass pipes and secondary channel. This method is time and labor intensive, has some impact on regular facility operation, and is possibly unsafe for employees. Applying research results to a CO_2 injection system that routinely operates with minimal human intervention and maintenance will have a significant impact on the overall predation problem.

Goals and Hypotheses

Goals:

1. Reduce overall predation in bypass pipes and secondary channel by developing a CO_2 injection system that can practically be used on a routine basis for effective predator removal.

2. Develop the injection system so that it can be easily implemented at the TFCF, is simple and safe to operate, effectively injects the correct quantities and rates of CO_2, reduces time required for predator removal, and is economically feasible; all at the "touch of a button."

Hypotheses:

1. The development and implementation of a CO_2 injection system will significantly reduce predation, increase employee safety, reduce time and labor associated with predator removal, and is economically feasible over time compared to existing systems and methods used at the TFCF.

2. Controlled injection of liquid and gas CO_2 through an automatic system provides more flexibility and control of CO_2 levels in the water than dry ice injection, resulting in more effective predator removal.

Materials and Methods

The study will be conducted at the Denver Technical Service Center in Denver, Colorado. The study will be conducted using a multidiscipline design team composed of engineers and fishery biologists. Tracy management and operators, particularly current

CO_2 researchers at the TFCF, will be drawn upon to provide input to and review of the study. This study will be conducted in two phases.

Phase 1: Prototype Development and Laboratory Testing

Two different automatic CO_2 injection systems will be developed (liquid and gas) based on results from past and current research as well as available resources and technology. The prototype systems will be developed and tested at the Hydraulics Laboratory in Denver, Colorado. Key variables to be tested include but are not limited to CO_2 injection quantity, flowrate, time, and diffusivity of CO_2 throughout the water column. Other factors such as mechanical/hydraulic performance, operational practicality and simplicity, maintenance, installation costs, operational costs, and safety of both systems will also be taken into account. Test results will be compared to current methods of CO_2 injection at the TFCF to determine the feasibility of implementing a new system in the field. Phase 1 will be completed by October 2011.

Phase 2: Field Implementation and Demonstration Testing

Following successful laboratory testing and design optimization, one prototype injection system (the one with superior test results) will be implemented at the TFCF for field testing and verification. Field testing will focus on the same factors analyzed during laboratory testing in Phase 1. This testing will include injecting CO_2 at the inlet to the bypass pipes using the new automatic system and the old dry ice method. Actual side-by-side comparison of the two methods in the field will illustrate how beneficial a permanent injection system will be to overall predation improvement. Demonstration testing will verify injection system effectiveness of predator removal, efficient and economic operation, and compatibility with existing infrastructure and facility operations. Results will be useful to determine the feasibility of implementing a permanent CO_2 injection system at this facility. Phase 2 will be complete by October 2013.

Coordination and Collaboration

The study will be coordinated between the TSC, Mid-Pacific Region, and TFCF staffs and the interagency Tracy Technical Advisory Team (TTAT) through regular updates and meetings.

Endangered Species Issues

Phase 1 of the study will not require permitting. In the second phase of the study, field trials will occur during months when listed species are not present at the facility.

Dissemination of Results (Deliverables and Outcomes)

Phase 1 will produce two physical prototype CO_2 injection systems, one liquid and the other gas. The prototype system with the best test results will be available for field implementation for Phase 2. The first phase will also include an interim report which includes feasibility level design drawings, appraisal level cost estimates, test results, and conclusions and recommendations. The interim report will be presented to the TFFIP manager and TTAT by October 2011.

A final feasibility design report that can be issued as a Tracy Technical Report will be delivered at the completion of Phase 2. This report will include all feasibility

design drawings and cost estimates as well as recommendations for future injection system use at the TFCF based on results from demonstration testing. The entire study is expected to be completed by October, 2013.

Literature Cited

Liston, C., C. Karp, L. Hess, and S. Hiebert. 1994. *Predator removal activities and intake channel studies, 1991–1992.* Tracy Fish Collection Facility Studies, Volume 1, U.S. Bureau of Reclamation, Mid-Pacific Region and Denver Technical Service Center.

Wu, B. and B. Bridges. *In Progress*. *Evaluating the use of carbon dioxide as an alternative predator removal technique to decrease Tracy Fish Collection Facility predator numbers and improve facility operations*. TFFIP Research Proposals, Fiscal Year 2009, U.S. Bureau of Reclamation.